

What is claimed is:

- 1        1. A circuit arrangement for use in communicating multiple signals over a  
2        common signal path between first and second clock domains during hardware-based  
3        logic emulation, wherein the first clock domain is emulated via a first multi-step  
4        evaluation cycle and the second domain is emulated via a second multi-step  
5        evaluation cycle, the circuit arrangement comprising:
  - 6                (a) a buffer interposed in a common signal path between first and  
7                second clock domains, the buffer including first and second locations, the first  
8                location associated with a first evaluation step in the first multi-step evaluation  
9                cycle and a first evaluation step in the second multi-step evaluation cycle, and  
10                the second location associated with a second evaluation step in the first multi-  
11                step evaluation cycle and a second evaluation step in the second multi-step  
12                evaluation cycle; and
  - 13                (b) logic circuitry coupled to the buffer, the logic circuitry configured  
14                to store in the first location of the buffer a first time-multiplexed signal output  
15                over the common signal path by the first clock domain during the first  
16                evaluation step in the first multi-step evaluation cycle, and to store in the  
17                second location of the buffer a second time-multiplexed signal output over the  
18                common signal path by the first clock domain during the second evaluation  
19                step in the first multi-step evaluation cycle, the logic circuit further configured  
20                to output the first time-multiplexed signal stored in the first location over the  
21                common signal path to the second clock domain during the first evaluation  
22                step in the second multi-step evaluation cycle, and to output the second time-  
23                multiplexed signal stored in the second location over the common signal path  
24                to the second clock domain during the second evaluation step in the second  
25                multi-step evaluation cycle.
- 1        2. The circuit arrangement of claim 1, wherein the buffer comprises a multi-  
2        port array including a write port and a read port, and wherein the logic circuitry  
3        comprises a write control circuit and a read control circuit respectively coupled to the  
4        write port and read port of the multi-port array, the write control circuit configured to

5 control storage of signals from the first clock domain in the multi-port array, and the  
6 read control circuit configured to control output of signals from the multi-port array to  
7 the second clock domain.

1           3. The circuit arrangement of claim 2, wherein each of the write and read  
2 control circuits includes a counter.

1           4. The circuit arrangement of claim 3, wherein the counter in the write control  
2 circuit is configured to be incremented during each evaluation step in the first multi-  
3 step evaluation cycle, and wherein the counter in the read control circuit is configured  
4 to be incremented during each evaluation step in the second multi-step evaluation  
5 cycle.

1           5. The circuit arrangement of claim 4, wherein the counter in the write control  
2 circuit is configured to be reset for each first multi-step evaluation cycle, and wherein  
3 the counter in the read control circuit is configured to be reset for each second multi-  
4 step evaluation cycle.

1           6. The circuit arrangement of claim 4, wherein the counter in the first multi-  
2 step evaluation cycle maintains a current evaluation step number for the first clock  
3 domain, wherein the counter in the second multi-step evaluation cycle maintains a  
4 current evaluation step number for the second clock domain, wherein the read and  
5 write control circuits are each configured to use the respective current evaluation step  
6 numbers stored in the respective counters to address the multi-port array.

1           7. The circuit arrangement of claim 1, wherein the first and second multi-step  
2 evaluation cycles have different numbers of evaluation steps from one another.

1           8. The circuit arrangement of claim 1, wherein the buffer is further interposed  
2 within a second common signal path between the first and second clock domains, and  
3 wherein the logic circuitry is further configured to store in the buffer time-multiplexed

4 signals output over the second common signal path by the first clock domain  
5 concurrently with storing time-multiplexed signals output over the first common  
6 signal path, and to output over the second common signal path from the buffer to the  
7 second clock domain, the time-multiplexed signals stored in the buffer.

1 9. The circuit arrangement of claim 1, wherein the first and second locations  
2 are each a plurality of bits wide, wherein the buffer is interposed within a multi-bit  
3 common signal path between the first and second clock domains, and wherein the  
4 logic circuitry is further configured to stored in the buffer multi-bit time-multiplexed  
5 signals output over the multi-bit common signal path by the first clock domain, and to  
6 output over the multi-bit common signal path from the buffer to the second clock  
7 domain, the multi-bit time-multiplexed signals stored in the buffer.

1 10. A logic board comprising the circuit arrangement of claim 9.

1 11. A logic emulator comprising the circuit arrangement of claim 9.

1 12. The logic emulator of claim 11, further comprising a plurality of  
2 emulation processor integrated circuit devices, at least one of the emulation processor  
3 integrated circuit devices configured to emulate the first clock domain, and at least  
4 one other of the emulation processor integrated circuit devices configured to emulate  
5 the second clock domain.

1 13. The logic emulator of claim 12, further comprising a plurality of logic  
2 boards, each including a subset of the plurality of emulation processors, and wherein  
3 the common signal path extends between emulation processors disposed on different  
4 logic boards.

1        14. A circuit arrangement for use in communicating multiple signals over a  
2 common signal path between first and second clock domains during hardware-based  
3 logic emulation, wherein the first clock domain is emulated using a first multi-step  
4 evaluation cycle and the second domain is emulated using a second multi-step  
5 evaluation cycle, the circuit arrangement comprising:

6                (a) a buffer interposed between the first and second clock domains  
7 within the common signal path, the buffer including a plurality of locations,  
8 each of which associated with an evaluation step from each of the first and  
9 second multi-step evaluation cycles;

10                (b) a write control circuit responsive to a first step signal associated  
11 with a current evaluation step in the first multi-step evaluation cycle, the write  
12 control circuit configured to store a signal output over the common signal path  
13 by the first clock domain in a location in the buffer that is associated with the  
14 current evaluation step in the first multi-step evaluation cycle; and

15                (c) a read control circuit responsive to a second step signal associated  
16 with a current evaluation step in the second multi-step evaluation cycle, the  
17 read control circuit configured to output a signal stored in a location in the  
18 buffer that is associated with the current evaluation step in the second multi-  
19 step evaluation cycle.

1        15. The circuit arrangement of claim 14, wherein the buffer comprises a  
2 multi-port array including a write port coupled to the write control circuit and a read  
3 port coupled to the read control circuit, wherein the write control circuit includes a  
4 counter configured to be incremented in response to the first step signal, and wherein  
5 the read control circuit includes a counter configured to be incremented in response to  
6 the second step signal.

1        16. The circuit arrangement of claim 15, wherein the counter in the write  
2 control circuit is configured to be reset for each first multi-step evaluation cycle, and  
3 wherein the counter in the read control circuit is configured to be reset for each second  
4 multi-step evaluation cycle.

1        17. The circuit arrangement of claim 15, wherein the counter in the first multi-  
2 step evaluation cycle maintains a current evaluation step number for the first clock  
3 domain, wherein the counter in the second multi-step evaluation cycle maintains a  
4 current evaluation step number for the second clock domain, wherein the read and  
5 write control circuits are each configured to use the respective current evaluation step  
6 numbers stored in the respective counters to address the multi-port array.

1           18. The circuit arrangement of claim 14, wherein the first and second multi-  
2       step evaluation cycles have different numbers of evaluation steps from one another.

1        19. A method of communicating multiple signals over a common signal path  
2    between first and second clock domains during hardware-based logic emulation, the  
3    method comprising:

4                (a) during each of a first plurality of evaluation steps in an evaluation  
5    cycle for the first clock domain, communicating a signal associated with such  
6    evaluation step across the common signal path from the first clock domain to a  
7    buffer that has a plurality of locations, and storing the communicated signal in  
8    a location among the plurality of locations in the buffer that is associated with  
9    such evaluation step; and

10                (b) during each of a second plurality of evaluation steps in an  
11    evaluation cycle for the second clock domain, wherein each of the second  
12    plurality of evaluation steps is associated with a location among the plurality  
13    of locations, communicating a signal from the location in the buffer that is  
14    associated with such evaluation step from the second plurality of evaluation  
15    steps to the second clock domain.

1        20. The method of claim 19, wherein communicating the signal associated  
2    with each evaluation step in the evaluation cycle for the first clock domain includes  
3    incrementing a first counter for each such evaluation step, and wherein  
4    communicating the signal from the location associated with each evaluation step in  
5    the evaluation cycle for the second clock domain includes incrementing a second  
6    counter for each such evaluation step.

1        21. The method of claim 20, further comprising resetting the first counter for  
2    each evaluation cycle for the first clock domain, and resetting the second counter for  
3    each evaluation cycle for the second clock domain.

1        22. A method of communicating multiple signals over a common signal path  
2 between first and second clock domains during hardware-based logic emulation,  
3 wherein the first clock domain is emulated via a first multi-step evaluation cycle that  
4 includes first and second evaluation steps and the second domain is emulated via a  
5 second multi-step evaluation cycle that includes first and second evaluation steps, the  
6 method comprising:

7                (a) during the first evaluation step in the first multi-step evaluation  
8 cycle, receiving a first time-multiplexed signal output over the common signal  
9 path by the first clock domain and storing the first time-multiplexed signal in a  
10 first location in a buffer interposed in the common signal path, wherein the  
11 first location is associated with the first evaluation step in the first multi-step  
12 evaluation cycle and the first evaluation step in the second multi-step  
13 evaluation cycle;

14                (b) during the second evaluation step in the first multi-step evaluation  
15 cycle, receiving a second time-multiplexed signal output over the common  
16 signal path by the first clock domain and storing the second time-multiplexed  
17 signal in a second location in the buffer, wherein the second location is  
18 associated with the second evaluation step in the first multi-step evaluation  
19 cycle and the second evaluation step in the second multi-step evaluation cycle;

20                (c) during the first evaluation step in the second multi-step evaluation  
21 cycle, communicating the first time-multiplexed signal stored in the first  
22 location over the common signal path to the second clock domain; and

23                (d) during the second evaluation step in the second multi-step  
24 evaluation cycle, communicating the second time-multiplexed signal stored in  
25 the second location over the common signal path to the second clock domain.

26

1        23. The method of claim 22, wherein the buffer comprises a multi-port array  
2 including a write port and a read port, the method further comprising incrementing a  
3 first counter for each evaluation step in the first multi-step evaluation cycle,  
4 incrementing a second counter for each evaluation step in the second multi-step

USPTO Patent Application

5 evaluation cycle, and utilizing the first and second counters to respectively address the  
6 write and read ports of the multi-port array.

1           24. The method of claim 20, further comprising resetting the first counter for  
2    each first multi-step evaluation cycle, and resetting the second counter for each second  
3    multi-step evaluation cycle.